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SECOND BIENNIAL REPORT

OF THE

COMMISSIONERS

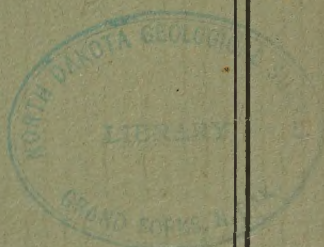
OF THE

Geological and Natural History Survey

Covering the period from
October 1, 1898, to September 30, 1900.



MADISON
DEMOCRAT PRINTING COMPANY, STATE PRINTER
1901



STATE OF WISCONSIN.

GEOLOGICAL AND NATURAL HISTORY SURVEY

BOARD OF COMMISSIONERS, 1901.

ROBERT M. LA FOLLETTE,

Governor of the State.

L. D. HARVEY, VICE PRESIDENT,

State Superintendent of Public Instruction.

CHARLES K. ADAMS,

President of the University of Wisconsin.

EDWIN E. BRYANT, PRESIDENT,

President of the Commissioners of Fisheries.

CHARLES S. SLICHTER, SECRETARY,

*President of the Wisconsin Academy of Sciences,
Arts, and Letters.*

STAFF OF THE SURVEY:

E. A. BIRGE, DIRECTOR AND SUPERINTENDENT.

C. R. VAN HISE, CONSULTING GEOLOGIST.

T. C. CHAMBERLIN, CONSULTING GEOLOGIST.

Pleistocene Geology.

E. R. BUCKLEY, ASSISTANT GEOLOGIST.

In charge of Economic Geology.

S. WEIDMAN, ASSISTANT GEOLOGIST.

In charge of geology of Central Wisconsin.

L. S. SMITH, *in charge of Hydrography.*

CHANCEY JUDAY, ASSISTANT BIOLOGIST.

W. S. FERRIS, ASSISTANT CHEMIST.

U. S. GRANT, ASSISTANT GEOLOGIST.

In charge of geology of the copper-bearing rocks.

N. M. FENNEMAN, ASSISTANT GEOLOGIST.

*In charge of physical geography of the lake re-
gion.*

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SECOND BIENNIAL REPORT

OF THE

COMMISSIONERS

OF THE

Geological and Natural History Survey

Covering the period from
October 1, 1898, to September 30, 1900.

NORTH DAKOTA GEOLOGICAL SURVEY
UNIVERSITY, N. DAK.



MADISON
DEMOCRAT PRINTING COMPANY, STATE PRINTER
1901



TABLE OF CONTENTS.

| | Page |
|---|------|
| Board of Commissioners..... | 3 |
| Staff of the Survey..... | 4 |
| Letter of Transmittal..... | 5 |
| Report of the Superintendent of the Survey..... | 7 |
| I. Personnel of the Survey..... | 8 |
| II. Financial Statement..... | 11 |
| III. Work of the Survey..... | 12 |
| A. Organization..... | 12 |
| B. Economic Geology..... | 13 |
| Investigation of clays..... | 13 |
| Road materials and road construction..... | 15 |
| Marls and Portland cement..... | 16 |
| Water supply..... | 17 |
| Mining industry..... | 17 |
| Building stones..... | 18 |
| C. Areal Geology..... | 18 |
| D. Investigation of the lakes..... | 20 |
| Hydrographic survey..... | 20 |
| Physical geography..... | 20 |
| Lake biology..... | 21 |
| E. Copper bearing rocks of North Wisconsin..... | 23 |
| F. Physical geography..... | 24 |
| IV. Publications..... | 25 |
| V. Plans for the future .. | 30 |
| Financial report from Secretary of State..... | 37 |
| Statutes of Wisconsin relating to the Survey... | 40 |
| Publications of the Survey..... | 42 |

STATE OF WISCONSIN.

GEOLOGICAL AND NATURAL HISTORY SURVEY

BOARD OF COMMISSIONERS.

EDWARD SCOFIELD,
Governor of the State.

L. D. HARVEY,
State Superintendent of Public Instruction.

CHARLES K. ADAMS,
President of the University of Wisconsin.

EDWIN E. BRYANT,
President of the Commissioners of Fisheries.

CHARLES S. SLICHTER,
*President of the Wisconsin Academy of Sciences,
Arts, and Letters.*

OFFICERS OF THE BOARD:

CHARLES K. ADAMS,
President.

EDWIN E. BRYANT,
Vice-President.

CHARLES S. SLICHTER,
Secretary.

JAMES O. DAVIDSON, STATE TREASURER,
Treasurer.

Oct. 1, 1900.

STAFF OF THE SURVEY.

E. A. BIRGE, Ph. D., Sc. D.,
Director and Superintendent.

C. R. VAN HISE, Ph. D.,
Consulting Geologist.

T. C. CHAMBERLIN, Ph. D., LL. D.,
Consulting Geologist, Pleistocene Geology.

E. R. BUCKLEY, Ph. D.,
Assistant Superintendent. Economic Geology.

SAMUEL WEIDMAN, Ph. D.,
Assistant Geologist. Geology of Central Wisconsin

S. V. PEPPEL, M. S.,
Chemist in Charge of Analysis of Clays (resigned August, 1900).

W. S. FERRIS, B. S.,
Assistant Chemist.

CHANCEY JUDAY, A. M.,
Assistant Biologist.

L. S. SMITH, C. E.,
In Charge of Hydrography.

U. S. GRANT, Ph. D.,
Assistant Geologist. Professor of Geology, Northwestern University. In Charge of Survey of Copper-bearing Rocks.

N. M. FENNEMAN, M. S.,
Assistant Geologist. Physical Geography of the Lake District.

Special assistants are also employed in the work of the Survey. Among these are: C. Dwight Marsh, Professor of Biology, Ripon College (Lake Biology); G. L. Collie, Professor of Geology, Beloit College, (Physical Geography); D. P. Nicholson, Professor of Geology, Lawrence University, (Geology of Northern Lake Region); L. S. Cheney, Assistant Professor of Botany, University of Wisconsin (Forest Trees).

LETTER OF TRANSMITTAL.

MADISON, October 1, 1900.

HONORABLE EDWARD SCOFIELD,
Governor of Wisconsin.

SIR:—The absence from the state by reason of illness of Dr. Charles K. Adams, President of the Commissioners of the Geological and Natural History Survey, makes it my duty to present to you, for transmission to the Legislature, the second biennial report of the Commissioners. This Survey was authorized by Chapter 297 of the Laws of 1897, and was furnished with means for the farther prosecution of its work by Chapter 163 of the Laws of 1899.

One change has occurred during the biennial term in the membership of the Board of Commissioners. Professor C. Dwight Marsh, of Ripon College, completed his term of service as President of the Wisconsin Academy of Sciences, Arts, and Letters with the year 1899, and Professor Charles S. Slichter, of the University of Wisconsin, who succeeded him as President, became thereby one of the Commissioners of this Survey, and has served in that capacity since the opening of the year 1900.

The very lucid and detailed report of Dr. E. A. Birge, the Director and Superintendent, accompanying this letter, renders unnecessary any recapitulation here of the work of the Commissioners since the last report. This report is adopted and submitted as the report of the Commissioners. It shows the work accomplished, the work unfinished, and the lines of investigation pursued. No argument is needed to prove that the means provided by the State have been expended in practical

work of great scientific value, and not less important from the material point of view.

The work assigned to the Commissioners embraces a wide field, and demands the labor of years. The task has been undertaken in all the lines of work prescribed by the act creating this board. A beginning has been made and the State is already receiving the benefit of the results accomplished.

The successful planning and prosecution of the work requires, as the Superintendent so cogently presents, that an adequate appropriation be made, and that it be made permanent, or, at least, extended over a longer term than two years.

In all the recommendations of the Superintendent, the Commissioners fully concur, and urge upon the Legislature action in accordance therewith.

Respectfully submitted,

EDWIN E. BRYANT,
President of the Board of Commissioners.

REPORT OF THE SUPERINTENDENT OF THE SURVEY.

To the Commissioners of the Geological and Natural History Survey:

GENTLEMEN:—I submit herewith my report on the operations of the Survey under your charge, from October 1, 1898, to September 30, 1900. At the date with which this report begins the income of the Survey was \$5,000 annually. The Legislature of 1899 increased the income of the Survey to \$10,000 annually. This increased appropriation became available about the middle of April, so that something more than six months of the two years covered by the report were carried on under the smaller appropriation, and a year and a half under the larger sum.

The increased appropriation became available in time for the field season of 1899, so that the Survey was able to enlarge very materially the scope of its work. The main direction of this increase was in the investigation of the Keweenawan, or copper-bearing rocks, in Northern Wisconsin. The field season of 1899 was devoted to an examination of these rocks as they are found in Douglas County, and that of 1900 to a study of the Southern, or Minong, range, most of which lies to the south of Douglas County. The work on building stones, which was completed by the spring of 1899, was replaced by work on the clays, which has been vigorously pushed and whose prosecution has involved the expenditure of a very considerable sum.

The two years have very materially increased our knowledge of the economic resources of the state, a not inconsiderable amount of work has been done in the scientific exploration of its geology, and at least a good beginning has been made on the

study of the biology of the lakes. Subsequent sections of the report will show in detail the amount and nature of the work which has been done.

Especial and cordial acknowledgment should be made at this point of the great assistance given by the United States Geological Survey in the matter of topography. Without this assistance the Survey would have been able to accomplish far less than has been done in the direction of geology. During the past two years the United States Geological Survey has completed the topography of the region about the Dalles. It has also surveyed the region now being investigated by Dr. Weidman, and has thus made it possible to work out the geology far more accurately than could otherwise have been done. It is impossible to conduct a geological survey with the care and accuracy necessary to detailed work at the present time unless the topographic survey has already been made. During the past season the United States Geological Survey extended into the southwestern part of Wisconsin the topographic work which had been done in former years in the adjacent parts of neighboring states, so that the topographic base for that region has been prepared and will be ready for this Survey, should we be able to undertake the investigation of the geology of that district next summer.

I. PERSONNEL OF THE SURVEY.

The following persons have been employed by the Survey during the past year with the compensation stated in each case. All persons paid by the year or month have been allowed their actual expenses while in the field, in addition to the compensation stated.

E. A. Birge, Director of the Survey, \$300 per annum until April 15, 1899; \$500 per annum since that date.

C. R. Van Hise, Consulting Geologist, without compensation except field expenses.

E. R. Buckley, Assistant Superintendent in charge of economic geology, \$800 per annum until April 1, 1899; \$1,400 per annum thereafter.

S. Weidman, Assistant Geologist in charge of areal geology, \$800 per annum until April 1, 1899; \$1,200 per annum thereafter.

U. S. Grant, Assistant Geologist in charge of Northern Wisconsin survey, \$100 per month while actually employed.

S. V. Peppel, Chemist in charge of analysis of clays, \$40 and \$80 per month according to the amount of time given to the Survey; employed from September 26, 1899, to August 26, 1900.

L. S. Smith, in charge of hydrography, \$5 per day while actually employed.

Chancey Juday, Assistant Biologist, \$800 per annum since July 1, 1900.

C. Dwight Marsh, Biologist, \$4 per day while employed in lieu of expenses.

D. P. Nicholson, survey of northern lakes, \$4 per day while employed in lieu of expenses.

W. W. Daniells, chemical analyses of copper-bearing rocks; compensation depending on amount of work done.

N. M. Fenneman, Assistant Geologist, physical geography of lakes of Eastern Wisconsin, \$100 per month while employed; engaged during part of the summer and autumn of 1900.

C. P. Berkey, Assistant to Professor Grant, \$60 per month while employed, about $2\frac{1}{2}$ months, summer of 1899.

H. M. Adkinson, Assistant to Professor Grant, summer of 1900; \$60 per month while employed, about 2 months.

H. F. Little, Assistant to Professor Grant summer of 1900; \$40 per month while employed, about 2 months.

W. S. Ferris, Chemical Assistant, analyses of marls and clays, \$50 per month, about 6 weeks, summer of 1900.

J. Lloyd Nelson, preliminary investigation of marls, summer of 1900; \$30 per month, engaged about seven weeks.

E. E. Hemmingway, Assistant to Professor Marsh, summer of 1899; \$50 per month while employed.

L. S. Cheney, forest tree bulletin; no compensation beyond expenses.

Besides the persons named above, Professor Grant's parties

have included several compassmen, cooks, etc., necessary to their parties, and a considerable number of persons have been engaged in various capacities for stenography and typewriting, drafting, and other office work and in various temporary employments connected with field work. The names of all persons who have received money from the Survey with the amounts paid in each case, appear in the statement of expenses from the Secretary of State, which is appended to this report. Miss Florence K. Denniston was engaged to draw the illustrations for Professor Cheney's report on the forest trees, and was paid various rates of compensation, according to the nature and amount of service rendered.

II. FINANCIAL STATEMENT.

Appended to this report is a statement from the Secretary of State, giving the names of all persons who have received money from the Survey, with the amount received by each. In the case of the permanent employees, the sums paid include not only salary, but also expenses while in the field, and the repayment of bills paid for the Survey. These latter sums are considerable and in some cases are more than the regular compensation whose amount has been stated in the preceding section.

In order that you may better appreciate the directions in which the money of the Survey has been expended, I have summarized the expenditures, not according to the persons to whom the money was paid, but by departments. The result is as follows:

| | 1898-1899. | 1899-1900. | Total. |
|---|------------|-------------|-------------|
| Administration..... | \$675 68 | \$1,230 06 | \$1,905 74 |
| Clays and Marls..... | 1,239 11 | 3,641 98 | 4,931 09 |
| Building Stone..... | 824 76 | 476 59 | 1,301 35 |
| Statistics of Wells | | 20 00 | 20 00 |
| Road Materials. | | 486 78 | 486 78 |
| Northern Wisconsin. | 1,662 00 | 1,949 76 | 3,611 76 |
| Areal Geology .. | 1,467 31 | 1,842 54 | 3,309 85 |
| Lake Biology | 588 26 | 503 86 | 1,092 12 |
| Lake Survey | 635 68 | 344 54 | 980 22 |
| Physical Geography..... | 238 00 | 143 50 | 386 50 |
| Physical Geography (Devil's Lake Bulletin)..... | 400 00 | | 400 00 |
| Physical Geography (Lakes)..... | | 131 75 | 131 75 |
| Forest Trees..... | 106 12 | 76 80 | 182 92 |
| Total | \$7,886 92 | \$10,855 16 | \$18,740 08 |

From this statement it appears that during the two years \$6,739.22 have been expended in the direction of strictly economic geology—building stones, clays, road materials, etc. The geology of Northern Wisconsin and that of the central crystalline area have used \$6,921.61, making a total spent for geology of more than \$13,600, or something more than 78 per cent. of the total expenditures. It appears also that the natural history of the state, in the larger sense, has been able to receive but a comparatively small portion of the income of the Survey, since the needs for the economic and general geology have been so pressing. During the two years covered by this report the sum of \$1,532.13 has been spent for apparatus and testing machinery.

Some explanation may be given to the sum allotted to administration. This has included \$925, paid the Superintendent during the two years as compensation for his services, both as director and as assistant in biology; \$290.04 have been spent for transportation, including freight and express bills; \$140.94 have been paid for clerical and other assistance. The Attorney General, in December, 1899, ruled that the changes

made in the Revised Statutes made it unlawful for the Superintendent of Public Property to issue stamps and stationery to the Survey; and during the past year \$195.41 have been spent for that purpose, including therein the purchase of a typewriter. We have spent \$259.48 in fitting up offices for the Survey in Science Hall, University. The regents of the University have granted the Survey the free use of space in this building, but it was necessary to partition off the offices and to equip them properly with furniture. During the first two years the Survey found accommodations in other offices in Science Hall, but the growth of the work, both of the University and of the Survey, made it impossible to occupy these quarters longer. The Survey is now well accommodated with offices, which will serve unless there should be a considerable increase in its permanent working force. The Survey is under great obligations to the University for providing us with these quarters.

On October 1, 1900, there remained of the money appropriated to the Survey by the Legislature of 1899 a balance of \$4,374.88, according to the report made by the Secretary of State. This sum will be sufficient to carry on the work of the permanent employees of the Survey and the necessary office and incidental expenses during the coming fall and winter, or until the appropriation made by the Legislature of 1901 shall be available.

III. WORK OF THE SURVEY.

A. I desire to repeat the acknowledgment made in the last report of the great value to the Survey of the service freely rendered to it by Professor C. R. Van Hise as Consulting Geologist. He has directed the work of the geological assistants, especially that of Dr. Weidman and Prof. Grant, and has given much attention to their problems, making several visits to them while in the field. Besides these services, he has always been ready to advise with the Director on all questions of importance relating to the welfare of the Survey and to advance its interests in every possible manner.

I am glad to be able to report that Professor T. C. Chamberlin, Director of the former Geological Survey, and now professor of geology in the University of Chicago, has consented to act as Consulting Geologist in regard to the Pleistocene geology of the state, with which he is especially familiar. His services began on the 1st of October, 1900, and therefore do not fall properly within the limits of this report. Like Professor Van Hise, he receives no compensation from the Survey beyond the payment of actual expenses while in the field.

B. Economic Geology.—The work of the department of economic geology has been for the past two years in charge of Dr. E. R. Buckley. The work of the two years has consisted of the completion and publishing of the building stone report, the investigation of the clays and clay industries of the state, the preliminary investigation of the marl deposits, the study of the road materials, and smaller amounts of work on the subjects of water supply, wells, and mining statistics.

Investigation of Clays.—Since May, 1899, the study of the clays and clay industries has been the main subject of economic importance, whose investigation the Survey has undertaken. During this time Dr. Buckley has visited all except two or three of the brick and tile factories operating at the present time, about one hundred and ninety in number. The clay banks have been carefully examined and the methods of manufacture and the economic considerations relative to the successful marketing of the products have been given consideration.

Samples of clay from about ninety localities were shipped to the Survey for examination. A few of these samples have been examined, both physically and chemically, but from the greater part only the chemical analyses have been made. The chemical work has been done by Mr. S. V. Peppel, assisted by Mr. W. S. Ferris. From the chemical analyses made the refractory quotient (or the behavior of the clays toward heat) has been computed. The refractory quotient will be checked up by experiments yet to be made for the determination of the fusibility of the clays. A complete report of the clay working industry of the state should include, besides discussion and description,

two series of tests,—one on the raw clay and one on the manufactured products. It is expected that during the present season all the samples of clay now in the laboratory will be thoroughly tested to determine their physical properties. When these tests have been made, it will be possible to state with a considerable degree of certainty the purposes for which the different clays occurring within the state can be used.

It has been thought best to publish the report on clays in two parts; the first part, which is to be printed at once, is largely descriptive in nature, containing only a small part of the chemical and physical tests. During the present winter it is thought that it will be possible to complete these physical tests, which will then be used as a basis for the second part of the report.

The first part of the report is essentially a summary of the present condition of the brick and drain-tile industry in Wisconsin, with chapters on the principles which are necessary to an intelligent understanding of the same. No attempt is made to discuss in detail the methods of manufacture of the different wares and the explanations of the difficult problems involved in the ceramic art are left to writers who are more experienced in the discussion of these subjects.

The investigation of the clays as thus far conducted shows that the state has enormous quantities of clay suitable for the manufacture of common building brick, terra cotta, fire-proofing, drain-tile, and earthenware. There are also less extensive deposits of clay which give evidence of being well adapted to the manufacture of ornamental building brick. It is believed that there are also limited deposits of clay that can be advantageously utilized for the manufacture of paving brick and other vitrified wares. The most refractory clay or shale found in this state is suitable for the manufacture of fire brick of moderate fire resisting qualities. Fire brick can be manufactured which are sufficiently refractory to serve the purpose for which three-fourths of the imported fire brick are used.

The very plastic white kaolin, which occurs in the western part of the state, is admirably adapted to the manufacture of the highest grades of porcelain. At the present time it is being

used almost exclusively in the manufacture of paper, for which purpose it is sold to the pulp and paper manufacturers of Minnesota, Wisconsin, and Michigan. This kaolin might be used successfully with the marl which occurs so abundantly in the northeastern part of Wisconsin, for the manufacture of Portland cement.

Many of the lower grade clays, such as occur in the vicinity of the Great Lakes and along the stream channels, are suitable for the manufacture of flower pots, cheap cuspidors, and other earthenware vessels of a similar character.

With the decreased output of lumber in Wisconsin, and the consequent rise in price, the people will be forced to use brick as a substitute for wood. The constant demand for a cheap and durable material will call into use enormous quantities of brick, stone, and concrete. Clay must be used in the manufacture of brick and terra cotta in this state, and will probably also be used in the manufacture of Portland cement. Everywhere the industrial and economic conditions point to the rapid development of the clay manufacturing industry.

Road Materials and Road Construction.—The Survey has devoted considerable time to an investigation of the improved highways of the cities, towns, and villages of the state. Data have been collected on the materials used in street construction and the methods of construction, in all parts of the state. Information has also been obtained on the cost of construction, cost of maintenance, and cost of cleaning. A knowledge of the manner in which the pavements have been constructed, the materials used, the location, traffic to which it will be subjected, and the conditions under which the pavement has been constructed, gives a basis from which a rational estimate of the life of the pavement may be made.

During the last few years there has been an increased demand for definite quantitative information concerning the relative value of different rocks used for macadam. About a year ago the Survey purchased an abrading machine and an impact testing machine, with which to make tests of the wearing and cementing qualities of different stones now being used for the

construction of macadam streets. Tests have been made on stone from the most important quarries, and although these are not published, they are available to the public on application. It is hoped that the Survey will soon be in a position to publish a report on the experiences of Wisconsin cities in highway construction, which will be a treatise on the materials available for street construction in Wisconsin cities and towns. It is proposed to make this report a work of reference for those who are interested in construction of highways in the towns, cities, or villages of Wisconsin.

Marls and Portland Cement.—During the last two or three years the Portland cement industry throughout the country has been developing very rapidly and the Survey has received many inquiries relative to the suitability of the deposits of marl occurring in various parts of the state for the manufacture of Portland cement. The limitation of the funds at the disposal of the Survey has made it impossible to begin as yet a thorough investigation of these deposits, but during the past summer the Survey attempted to determine the extent and character of some of the marl deposits which have been reported from the central, eastern, and northeastern parts of the state. For the purpose of collecting samples and determining the areal extent and depth of these deposits, Mr. J. Lloyd Nelson spent seven weeks during the summer of 1899 in Door, Kewaunee, Waupaca, Shawano, Langlade, and Waushara counties. During the time that Mr. Nelson was in the field he inspected some twenty-five marl beds, some of which covered an areal extent of a hundred acres and having a depth of from one to forty feet of marl. The marl deposits inspected vary greatly in their character and composition; some of the deposits are thoroughly decomposed, while others contain a great many shells and some coarse sand.

Borings were made in many parts of each of the deposits, so that the quantity of the marl contained in the deposit is easily computed. Samples were collected from various parts of the deposits, both from the surface and deep within the deposit. These samples are now in the laboratory of the Survey and will be analyzed during the present winter.

There seems little question that these deposits of marl are sufficiently pure to be utilized advantageously in the manufacture of Portland cement. The Survey is examining deposits of clay in the immediate vicinity of the marl beds to determine whether or not the clay occurring at these places can be used in the manufacture of Portland cement. It is a well recognized fact that suitable clay must be found near to the marl in order to make the manufacture of the Portland cement cheap enough to be sold in competition with cement now on the market.

The report on the marls cannot be published for a year or more, but the information collected is available to the public upon application. However, it is the intention to issue a report on this important subject as soon as possible, in order to make the information which has been collected more accessible to parties interested in the development of this industry. It is thought that a preliminary report on this subject will be of value to the state.

The Water Supply of the State.—The Survey has been continuing to collect statistics on well borings throughout the state, although the responses of the well drillers are not very numerous. The data which have been obtained by the Survey are valuable in showing the depth at which water is now being obtained and the character of the rock formations passed through. It is expected to continue the collection of data on well borings, although it may be a long time before the well drillers as a whole attach sufficient importance to the subject to make the information especially valuable. However, when once collected and collated, the data will be of inestimable value to the well drillers of this state.

The Mining Industry.—The collection of statistics of the iron mining in the northern part of the state and the lead and zinc mining in the southwestern part has been begun. None of the mines, with the exception of those in the southwestern part of the state, have received any attention further than the collection of statistical data. Dr. Buckley spent a short time in Southwestern Wisconsin inspecting some of the more important mining properties, with a view to the necessity of continuing

the work of the former Survey in this region. The needs of the miners in Southwestern Wisconsin are very apparent and it is hoped that the Survey will be in a position during another year to do some work in this region.

Throughout the state there has been continual applications on the part of men interested in the developing of mining properties for the assistance of the Survey in inspecting the undeveloped regions. As far as time would permit, Dr. Buckley has visited these mining properties and given such information and assistance as was possible under the existing conditions.

This department receives many mineral specimens to be identified and reported upon. Each request which has been received has been given careful attention; the minerals have been examined with reference to their economic importance and the best judgment of the geologist in charge has been given to those making requests for information.

Building Stones.—The work which was done during the preceding two years on the quarrying industry of the state has furnished a basis from which the Survey has been able to give information and much needed assistance to quarrymen and parties desiring to use Wisconsin stone. Dr. Buckley has been able to visit a number of undeveloped deposits of stone and render assistance to men desiring to enter this field of industry. The Survey has been in a better position to assist the quarrying industry during the last two years than it was the first two, and each succeeding year the Survey purposes to render to the quarrymen throughout the state assistance and information which will materially aid them in the development of any deposits which merit exploitation.

C. Areal Geology.—The Wausau district forms an area approximating four thousand square miles, and is located in the central part of the state in the vicinity of Antigo, Merrill, Medford, Wausau, Marshfield, Grand Rapids, and Stevens Point. The district consists principally of the crystalline rocks and includes extensive formations of slate, quartzite, granite, and trap rock. In the western and southern part of the district the sandstone formation is abundant, while overlying both the older

crystalline rocks and also the sandstone are deposits of glacial drift, distributed irregularly throughout the district.

The geology of the crystalline rocks is very complicated and it is often very difficult to determine the origin and relations of the various formations. These formations are of Huronian and Archean age, the former being the system of rocks in which the iron ores of the Lake Superior region are found. This fact has led many to believe in the possibility of finding iron ore and other valuable minerals in this region. It has been estimated that from \$75,000 to \$125,000 have been expended for the purpose of discovering and mining ores of iron, gold, copper, and silver in the vicinity of Wausau alone. This expenditure was a complete loss to the investors. It can be stated with certainty that if a geological survey of the locality had been made at an earlier day this loss could have been averted. The present geological survey of the crystalline rocks of the state, however, is not only for the purpose of determining the presence or absence of ore bodies, but also for the purpose of locating and examining all the various kinds of rocks of the region, the occurrence of the building and monumental stones, of clays, and road metal, and thereby furnishing the people of the state with a valuable fund of information which will be of service to those in quest of these materials.

In carrying on the work of the Survey every ledge of rock is examined, located upon the section map, and many specimens collected for further study in the laboratory with the microscope and by chemical analysis. Since the Wausau district is fairly well settled, the work in the field is being almost wholly done by using the bicycle, which is not only a very inexpensive mode of travel, but is also rapid and well adapted to the field work. The fact that the area is well settled and much of the forests cleared away, also aids in finding the rock exposures, and in obtaining other valuable information which was not accessible when the former geological survey was made about twenty-five years ago.

During the season of 1899 about six months were spent in the field and an area of eight hundred square miles in the vicinity of Marshfield and Medford was mapped. During the past sea-

son, 1900, about seven hundred square miles were surveyed between Marshfield and Grand Rapids.

In the work of the past season special attention has been paid to the mapping of the various glacial formations of the district. The nature of the soils is directly dependent upon the glacial geology and thus the detailed mapping of the glacial deposits will furnish a basis for the soil mapping of the district. In studying and mapping the soils samples of the average soils will be collected and their texture and composition studied in the laboratory. It is apparent that the mapping of the soils of the region will assist in developing the agricultural resources of this part of the state.

D. Investigation of the Lakes.—This Survey has now made a fair beginning on the study of the inland lakes of the state. The completion of this work will undoubtedly occupy a considerable number of years. The work hitherto done falls under three heads:

Hydrographic Survey.—A hydrographic survey has been made of most of the important lakes of Southern and Eastern Wisconsin from Green Lake, the Waupaca Lakes, and Elkhart Lake on the north. This work has been in charge of Professor L. S. Smith of the University of Wisconsin. He has now completed the survey of more than 60 lakes, ranging in size from Lake Mendota, Green Lake, and Lake Geneva, to the small lakes of the Waupaca chain. While numerous lakes still remain unsurveyed, even in the district under consideration, they are most of them either small or shallow. The Survey has expended in this department considerable sums of money in the period covered by the first biennial report, but much smaller amounts in the last two years. While the survey will be extended to lakes which are found to have an especial interest, the general work of this character is now regarded as nearly complete and the main attention of the Survey will be given to other departments.

Physical Geography.—The lakes which have thus been surveyed are most interesting from a physiographic point of view, including several types of lake basins. The study of the nature and origin of these lakes and the surface geology with which

they are associated has been assigned to Professor N. M. Fenneman, formerly of Greeley, Colorado, who has given to the investigation much of the summer of 1900.

All the lakes of which a hydrographic survey has been made, and some others, have been examined, and the results of this study are being prepared for publication as an Educational Bulletin. The lakes already visited include Geneva, Delavan, Beulah, the Lauderdale Group, those of the Oconomowoc district, the lakes at Madison, Big Cedar (Washington County), Elkhart, Green, and the Waupaca Chain, with minor bodies of water in the vicinity of those named.

The points to which attention has been directed include the geological history of their basins, their relation to the surrounding topography, the history of the lakes with respect to former levels, the progress of surface agencies tending to extinguish the lake, the geological and scenic features of coasts, the changes being wrought upon the shores and features being developed by the action of waves and currents, the work of ice, and the laws of sedimentation as illustrated in the lakes studied.

A considerable collection has already been made of photographs which are designed primarily to illustrate the features and processes discussed. But in addition to this scientific use, they serve to emphasize the rare beauty and attractiveness of these lakes which are among the important natural resources of our state.

It is intended that the report shall be of a character helpful to teachers in appropriating the varied features of our lakes to the work of education, and at the same time consistent with the needs of general readers.

Lake Biology.—The study of the biology of the lakes has been carried on from the beginning of the Survey by the Superintendent and by Professor C. Dwight Marsh. The progress of the work has necessarily been slow, since only their leisure time could be devoted to it. The completion of the hydrographic surveys, with the attendant reduction of expenditure in that direction, permitted the employment of a biological assistant in 1900, and Mr. Chancey Juday has been appointed to that position.

The investigations hitherto carried on have concerned the lower life of the open water—the so-called *plankton*. On this supply of plants and animals, the higher life of the lakes depends in large measure for its support. Comparatively little study has been given in this country to this department of lake biology and this Survey has, therefore, given it the first place.

Professor Marsh spent several weeks of the summer of 1899 in a comparison of the biological conditions of Lake Winnebago and Green Lake. These were selected because the first is a large and very shallow lake and of great practical interest from the standpoint of the fisherman. This lake and others connected with the Fox and Wolf rivers, produce fish in enormous quantities—greater probably than any other of the inland lakes, so that Lake Winnebago is a peculiarly interesting body of water for the student of fresh water life. Green Lake, on the other hand, is a typical deep water lake, whose life resembles in many respects that of the great lakes. These two bodies of water, therefore, lying so near to each other, represent extremely different biological conditions and a comparison of their life is peculiarly instructive. In 1899 Professor Marsh gave most of his time to the study of the fauna of Lake Winnebago, as he was already well acquainted with that of Green Lake. A temporary laboratory was fitted up at Stony Beach, largely with apparatus loaned from the laboratories of Ripon College, and for two months of the summer Professor Marsh and an assistant carried on the collection and study of material from this lake. Since this time collections have been made at regular intervals from both Green Lake and Lake Winnebago and several trips have been made to lakes in more distant parts of the state. The investigation of the material collected is still going on and considerable additional collecting and study must be done before any general results can be reached.

The Superintendent and Mr. Juday have been engaged in a somewhat similar investigation of the life of various lakes, ranging from Lake Geneva to the Waupaca Lakes. The work has been of a preliminary character, designed especially to ascertain the lakes whose fauna and flora furnish the best oppor-

tunities for more detailed investigation in the future. The Superintendent has also been completing a somewhat elaborate study of the temperatures of these lakes, as furnishing one of the important conditions for life. A report on this subject has long been nearly finished, but its completion has been delayed by pressure of administrative work. It is, however, nearly ready for the press and will be published in the immediate future.

E. Copper-bearing Rocks of North Wisconsin.—It was understood that one of the main subjects of investigation by the Survey during the two years past would be the copper-bearing rocks of Northern Wisconsin. On the organization of the field work for the summer of 1899 Professor U. S. Grant, then connected with the Geological Survey of Minnesota, was appointed to take charge of this investigation. Professor Grant had had long experience on the Minnesota Survey with the rocks adjacent to Lake Superior, and was, therefore, peculiarly well fitted to undertake this difficult investigation. During the field season of 1899, which lasted from May 15 to September 1, he was assisted by Dr. C. P. Berkey of the University of Minnesota. The areas studied in detail were as follows:

(1) *The St. Croix Range.*—This range was mapped in detail for an area twenty miles in length (N. E. and S. W.) by four to six miles in width, traverses being made north and south across the range usually every half mile. This work extended from the southwest corner of Douglas County northeast to and including T. 45 N., R. 12 W. Outside of this area a small amount of reconnaissance work was done.

(2) *The Douglas Copper Range.*—This range was mapped in detail from the west side of T. 47 N., R. 14 W., to the east side of T. 48 N., R. 10 W. This area included all of this range in the state except for a distance of six miles on the western side of Douglas county. The area mapped in detail is forty miles long (east and west) and from three to four miles wide. Outside of this area a small amount of less detailed work was done. In the latter part of the season a trip, for comparative study, was taken to the copper-producing district of Michigan.

During the winter a preliminary report on the copper-bearing rocks of Douglas County was prepared and published as Bulletin No. VI of the Survey. This bulletin contained 55 pages, four maps, and seven illustrations of localities interesting geologically or of economic importance in this district. This bulletin was issued in the spring of 1900 and was sent out to all persons applying for it. The greater part of the edition, however, was retained in order that the results of the investigations of the summer of 1900 might be incorporated.

The field season of 1900 lasted about two months, July and August. Professor Grant was assisted by Mr. H. M. Adkinson, of the University of Chicago, and Mr. H. F. Little, of Northwestern University. The area studied in detail extends from the west side of T. 42 N., R. 11 W., to the east side of T. 45 N., R. 6 W. This area is about forty miles in length (northeast and southwest) and from four to six miles in width. It includes the important parts of the copper-bearing rocks in Washburn and Bayfield counties, except for a distance of six miles on the east side of Bayfield County. Outside of this area a small amount of less detailed work was done. At the close of the field season, Professor Grant began the preparation of a brief report on the rocks of the area studied during 1900. This will be printed as an additional chapter and incorporated with the report of the work of 1899, and will be issued as a second edition of that report. The chapter on the general geological and economic conclusions will also be revised in the light of the additional knowledge which has come from the investigations of the past summer.

F. Physical Geography.—Professor D. P. Nicholson has now spent three seasons in field work on the lake region of Northern Wisconsin. This is an area roughly triangular in shape, about 45 miles from north to south and 60 miles from east to west and including about 2,000 square miles. The region contains 800 lakes, or more, and much of it is still covered by forest. Access to the district is gained by the C. & N. W. and C., M. & St. P. railroads, by some county roads, and by numerous logging roads. Professor Nicholson has traversed

the district in all directions and is now preparing a report, both on the general geology of the country and on the lakes and the topography intimately connected with them. He has also made a reconnaissance of the lake region in the St. Croix valley, in order to compare the geology of that district with that of Northeastern Wisconsin. The lakes of the northeastern part of the state lie in an area bounded north and south by moraines; the lakes extending into the moraine on both sides. Between the moraines is a sandy plain between 20 and 30 miles in width, sloping to the south, in which lie most of the very numerous lakes. These are usually shallow; the greatest depth found being 95 feet, while most do not exceed 30-40 feet in depth.

This region is one which now attracts many thousands of summer visitors annually and is, therefore, well worthy of special report. Professor Nicholson's account of the district will be written in such a way as to be of general interest, as well as of scientific value.

The first publication on the physical geography of the state has been issued during the past two years, namely: Professor Salisbury's bulletin on The Geography of the Region about Devil's Lake and the Dalles of the Wisconsin. This publication is spoken of in a later section of the report, and the work of Professor Fenneman, on the physical geography of the lakes of Southern and Eastern Wisconsin is mentioned on a previous page.

IV. PUBLICATIONS.

During the past two years the Survey has issued four bulletins; two of which belong to the Economic Series on one each to the Scientific and the Educational Series. The titles of these bulletins are as follows:

Bulletin No. III. Scientific Series No. 2.—A CONTRIBUTION TO THE GEOLOGY OF THE PRE-CAMBRIAN ROCKS OF THE FOX RIVER VALLEY, WISCONSIN. Samuel Weidman, Assistant Geologist Wisconsin Geological and Natural History Survey. Pp. 63; 10 plates.

Bulletin No. IV. Economic Series No. 2.—THE BUILDING AND ORNAMENTAL STONES OF WISCONSIN. E. R. Buckley, Assistant Geologist Wisconsin Geological and Natural History Survey. Pp. 544; 69 plates, of which seven are colored, and one map.

Bulletin No. V. Educational Series No. 1.—GEOGRAPHY AND SURFACE GEOLOGY OF THE REGION OF DEVIL'S LAKE AND THE DALLES OF THE WISCONSIN. R. D. Salisbury, Professor of Geographic Geology, University of Chicago, and W. W. Atwood. Pp. 146; 38 plates, 47 figures in the text.

Bulletin No. VI. Economic Series No. 3.—THE GEOLOGY OF THE COPPER-BEARING ROCKS OF DOUGLAS COUNTY. U. S. Grant, Professor of Geology, Northwestern University. Pp. 55; 11 plates, of which four are maps.

Bulletin No. III by Dr. Weidman was issued late in the year 1898 and is a careful scientific study of the old volcanic rocks in the neighborhood of Berlin, Waushara, and Utley. These rocks are extensively quarried and are of considerable economic importance, as well as of scientific interest. The report deals with them from the scientific point of view.

Bulletin No. IV by Dr. Buckley, is by far the largest publication that the Survey has yet issued. It treats of the building stones of the state, both from the scientific and the practical point of view, and describes each of the important quarries; thus giving a full account of the industry. It is fully and beautifully illustrated by 69 plates; seven of which are colored, illustrating the main types of granites and sandstones. These plates were photographed from the stones and were engraved and printed with great care and skill and are among the most successful illustrations of stone hitherto published. Five thousand copies of this bulletin were printed, of which something more than half have already been distributed. There has been a large and constant demand for this report since it was issued, in July, 1899.

Bulletin No. V is the first educational bulletin which the Survey has issued. It is an unusually successful attempt to present the results of careful and independent scientific study in such

a manner that it will be both available as materials for school instruction and of interest to the general reader. It deals with the development of the topography and scenic features of the Devil's Lake region—one of the most interesting districts of the state from a scientific point of view and one whose scenery is of great economic value. The senior author of the bulletin—Professor Salisbury—has devoted a large amount of study to this district, as he has annually spent several weeks there in field work with his classes. The bulletin has aroused much interest among the teachers of the state and has been more sought for by them than has any other of the publications of the Survey.

Bulletin No. VI is a preliminary account of the survey made by Professor Grant of the copper-bearing rocks in Douglas county. This bulletin was issued in the spring of 1900, in order that the results might be made public before the open season of that year. During the following summer Professor Grant extended his work to the southern, or Minong, range, which lies almost entirely to the south of Douglas County. Professor Grant has completed a similar report on this region and the general results have been rewritten in the light of the additional information obtained during the summer. This report will be printed as a new chapter of Bulletin No. VI, which will be issued in a second edition with this additional matter.

At the time of the issuing of the last biennial report, one of the hydrographic maps had been issued—that on Lake Geneva. Since that date seven additional maps have been printed and two more are in the hands of the printer. The maps that have been issued thus far are as follows:

No. 1. Lake Geneva. Scale, two inches to the mile.

No. 2. The Oconomowoc-Waukesha Lake District. Scale, two inches to the mile.

No. 3. Lake Beulah. Scale, six inches to the mile

No. 4. Elkhart Lake. Scale, seven inches to the mile.

No. 5. The Chain of Lakes, Waupaca. Scale six inches to the mile.

No. 6. Delavan and Lauderdale Lakes. Scale, four inches to the mile.

No. 7. Green Lake. Scale, three inches to the mile.

No. 8. Lake Mendota. Scale, three inches to the mile.

There are now in the hands of the printer the following maps:

No. 9. Big Cedar Lake, Washington county.

No. 10. Lake Monona.

All of these maps except Nos. 8 and 10, furnish the hydrography alone, since the funds at the disposal of the Survey did not permit the determining of the topography of the land adjacent to the lakes. In the survey of Lakes Mendota and Monona, however, the topography of the shores was determined without expense to the Survey by the students of successive classes in the University of Wisconsin. These maps, therefore, contain much information about the shores which is lacking in the others. More care, therefore, has been taken in issuing these maps and they have been lithographed, while in the other cases the outlines of the map are a photographic zinc etching. The depth of the water in each lake is indicated by contour lines usually placed at 10 foot intervals. In the case of Green Lake, however, the interval is 20 feet, as the lake is very deep and its shores are steep, so that the use of the smaller interval would add little or nothing to the information given by the map. Lakes Monona and Mendota have been very carefully sounded, especially in the region of the shore, and their depth is shown by 5 foot contours. In all of the maps the depth of the water is also indicated by a blue tint, increasing in strength of color with the depth of the water.

Lakes Kegonsa and Waubesa have been surveyed and a map containing these lakes is now being drawn. Altogether some 58 lakes have been thus surveyed, or, if the separate basins are reckoned in the Lauderdale Lakes and Lake Beulah, the number will be increased to 63. The Survey has thus been able to bring together a large amount of accurate information regarding a considerable number of lakes in the southern part of the state. This will serve as a basis for further investigations into the life of the lakes. Such investigations can now be made with an accuracy which would be entirely wanting if the knowledge of the depth and slope of the shores was conjectural or derived from superficial observation only.

The larger part of the edition of each of these maps has been left unfolded for future use as the necessities of the Survey indicate. About 1,000 copies of each map have been folded and provided with manilla paper covers for immediate distribution and use.

Future Publications.—I have already stated that two maps—those of Lake Monona and Cedar Lake—are in the hands of the printer and will probably be issued before the appearance of this report, and that the map containing Lakes Kegonsa and Waukesha is now being drawn and will be issued in the near future. Several bulletins are in press, or are in active preparation. The first part of Dr. Buckley's report on the clays and the clay industries of the state is now in the hands of the printer and will probably be issued by the first of March. The bulletin by the Superintendent of the Survey, on the temperatures of the lakes in Southern and Eastern Wisconsin, is now nearly ready for the press and I trust will be in the hands of the printer before the close of the year. Professor Nicholson is actively engaged in preparing his report on the lake region of Northeastern Wisconsin. The field work for this report is now finished and the report should be ready for publication very shortly. Professor Fenneman is writing the results of his study on the physical geography of the lakes of Southern and Eastern Wisconsin. While this report will be written during the coming winter, it is not probable that it will be ready for publication until some time during the summer of 1901, since it will apparently be necessary to revisit next summer some of the lakes in order to complete the field work.

I had fully expected that Professor Cheney's report on the forest trees of the state would be in print before the date of this report, but the serious illness of Professor Cheney prevented him from doing any work during the summer, and, as a result, the preparation of this bulletin has been correspondingly delayed. The drawings for the illustrations have been completed for nearly a year and a great part of the text is now ready. During the present college year also, I expect the completion of a bulletin by Professor Hobbs of the University of Wisconsin,

on certain volcanic rocks from the center of the state. This bulletin will resemble in matter and scope the report by Dr. Weidman, which has already been issued at Bulletin No. III. It will serve as an extension and completion of the detailed work on this group of rocks in the state. The Survey has, therefore, at present in press or in active preparation the materials for six new bulletins. During the coming winter Dr. Buckley will go on with the more detailed scientific tests and investigations of the clays of the state in preparation for a second part of his report on that subject.

V. PLANS FOR THE FUTURE.

The first duty assigned to this Survey by the statute which established it (Chapter 297, Laws of 1897) was the completion of the geological survey of the state in both its scientific and economic aspects. To this work the Survey has devoted out of the appropriations made by the state far more than to any other department. In carrying out the first duty named,—the completion of the geological map of the state,—Dr. Weidman was at once engaged to work out the intricate and difficult geology of the great central area of crystalline rocks, whose detailed survey was not possible twenty-five years ago on account of the unsettled condition of the country. This work has been steadily carried on and more than 3,000 square miles of this area have now been carefully examined. The crystalline area includes, however, some 25,000 square miles, and, while the most difficult part of it has been studied, some years must still elapse before the work can be completed with the force at the disposal of the Survey. Where the funds at the command of the Survey permit the employment of a single geologist only, progress must necessarily be somewhat slow. The area covered by the Survey is also small, on account of the difficulties of the geology and in part of the region on account of the small number of exposures of rock.

During the last year and a half the department of economic geology of the Survey has been devoting its attention more par-

ticularly to the study of clays, marls, and road materials. The demand for information along these lines has been constant and increasing. The funds at the disposal of the Survey have not permitted the placing of forces in the field sufficiently large to complete these reports in two years, and the work at the present time has practically only been begun. The first part of the bulletin on the Clay Resources of the state will soon be published. An examination of this report will give some idea of the importance of the subject which is treated and furnishes a better conception of this vast undeveloped field which is yet to be opened up. This subject of the clay resources has not been completed. There are many tests which must yet be made to determine the suitability of the clay deposits for purposes other than those for which they are now used. It will require at least some time to complete the second part of the report, but, when finally published, the first and second parts will be equivalent to the report on the building and ornamental stones issued two years ago. The investigation of the clays has been a much more difficult problem to undertake than was that of the building stones. This investigation requires the expenditure of much more money and requires more labor and care than the investigation above referred to. If the second part of this report is completed in two years there will be at the disposal of the people of the state information of inestimable value on the clay resources of the state.

The Survey has begun the investigation of the marls of the state. This work was carried on in the field for about six weeks during the last summer, but could not be continued on account of limited funds. The investigation, so far as conducted, shows that the state is rich in deposits of marl which are thought to be of sufficient purity to be used in the manufacture of Portland cement. It is hoped that during the next few years the marl deposits can be thoroughly explored along with the clays, and information given to the public whereby Portland cement manufactories may be established. The Survey is constantly receiving inquiries relative to the occurrence of marls in the state, but the expensive character of the chemical work con-

nected with their investigation has necessarily made the answers to these inquiries indefinite.

Iron, stone, brick, terra cotta, and lime are certain to be the constructional materials of the future, not only for this state, but for every state where the lumbering industry is being rapidly extinguished by the cutting of the forests. It seems especially fitting that the Geological Survey should be continued until these important resources have been thoroughly investigated and the public has become well informed upon every phase of these subjects so important to the future of Wisconsin. The Geological Survey makes itself a bureau of information, from which information may be obtained at any time relative to these subjects. Brick makers, quarrymen, miners, cement manufacturers, and other men engaged in the development of the natural resources of the state may apply to this bureau for information and obtain assistance in locating the resources in which they are interested. The information and opinions which they obtain on the character and value of the deposits are entirely impartial and the investment of money in new enterprises becomes sure if such information is obtained from men who are not interested from a financial standpoint.

Not only have the brick and cement resources been given attention by the Survey, but a laboratory has been equipped with machinery for testing road materials. Considerable time and attention has been paid to the determination of the value of the different rocks occurring within the state for purposes of building macadam roads. The wearing and cementing qualities of different kinds of rock have been determined. Information has also been sent to various cities and companies as to the value of different stones for this purpose. The work which the Survey has undertaken in this direction can not be completed in a year or two years, but must necessarily require many years before it is ultimately finished. These tests cannot be made all at one time, but must be completed as there is a demand for them. This demand will not come in one year, but will come year by year, as occasion requires. The knowledge which the Survey has of the stone resources of the state makes it espe-

cially fitting that this should be the source from which to obtain information as to the best materials for the improvement of the highways of the state.

The lead, zinc, copper, and iron mining interests should not be neglected. For two years the Survey has had a party in the northern part of the state, investigating the copper resources. The Keweenaw rocks, in which the copper occurs, extend over a large part of the state, and it is evident that a small party of two or three men cannot cover the whole region in so short a period as has been allotted to the work by the Survey. The Survey has been unable to give any attention whatever to the important lead and zinc resources of the southwestern part of the state. The people who have become interested in the development of mining in this section of the state are very desirous that we should give them assistance in opening up new districts and in working up the old ones in that region. They desire the direction of the ranges, the depth of known openings, and the depth at which the different beds of ore occur. They are also in need of expert work on the analysis of ores and rock and the method of treatment and reduction. It is hoped that with the continuation of the Survey sufficient provision will be made so that assistance may be given from year to year to the people in the mining districts of the state. It is not expected that the work which is necessary can be done in two or three years, but it is hoped that it may be begun during the next year and continued as long as assistance is required.

Not infrequently demands are made of the Survey for information concerning the character and nature of the water supply in different parts of the state. Well drillers seek information concerning the character of the rock which they will be required to pass through in drilling wells in different parts of the state. They also desire the depth at which they can get water. This information can only be given after a vast amount of information has been gathered relative to the present well borings. As rapidly as possible, the Survey is collecting this information and it is hoped that before many years we will be in a position to furnish much information to the people en-

gaged in this work. The problem of water supply in this state is very important to the people and should be given its share of attention along with the investigation of the other resources.

The Survey has been unable to do much in the direction of the investigation of the forests. Its first piece of work was a preliminary survey made by Mr. Roth of the United States Department of Agriculture, whose expense was shared by that department and the Survey. This report furnishes a basis on which further investigations can and ought to be made, and on which practical work in forestry can be started. Other pressing necessities, however, have prevented the appropriation of funds for this purpose, and the only work done during the last two years on the forests has been in the direction of the preparation of Professor Cheney's bulletin on the forest trees of the state, to which the Survey has devoted small sums for the payment of Professor Cheney's actual expenses in the field, and for the preparation of drawings to illustrate the report. Unless the funds of the Survey are increased, it will not be practicable to extend its work in this direction.

The study of the lakes of the state, with their animal life, has been progressing slowly. Until the summer of 1900 the study of the animal life has been carried on by the Director and by Professor Marsh only. Last July a biological assistant was engaged for the first time, and a beginning is now made of systematic work on this subject, extending throughout the year. This work must necessarily move slowly, since much of it is in new and untrodden fields, and it will be better to carry on the investigations with a moderate force than to attempt to expend large sums at once. The lakes of the state are, however, one of its most valuable natural resources, both as related to the fish-culture, and especially in relation to the presence of summer visitors. It is the intention of the Survey, therefore, to bring together gradually the information out of which can be made a complete report on the lakes of the state, especially those of the southern and eastern part, in regard to their hydrography, physical geography, the chemistry of their waters, and their life—both that of the lower forms of being and those of economic importance.

A beginning has been made on the account of the physical

geography and natural history of the state in the publication of Professor Salisbury's bulletin on the Devil's Lake region, and in the preparation of Professor Fenneman's account of the physical geography of the lakes of the state. This work should be carried on by the Survey about as it has been in the past taking up one type after another of the physical geography of the state as opportunity offers, and as the money at the disposal of the Commissioners permits. No state in the Union has a more varied topography, or is better suited for illustrating the principles of physical geography, and the Survey should aim at preparing a series of educational reports which should ultimately cover all of the districts of the state and which can finally be brought together into one general account of the principles of physical geography and surface geology, based on the facts as found within our own limits.

This account of the work done by this Survey during the past, and that which still lies before it, shows several things: First, that a large amount of investigation valuable to the people of the state and needed by them, has been already accomplished by this Survey; second, that the amount of work remaining to be done is far greater than that which has been done in the past; and, third, that the amount of investigation needed is so great and the nature of the demands made upon the Survey are such that its work cannot be finished in three or four years. If the duties of the Survey were purely scientific—the completion, for instance, of the geological map of the state or the preparation of a report on its animal life or its plants—it would be possible to set a time at which this task could be finished, if the amount of money to be devoted to it were known, but the investigation of the varied natural resources of the state offers problems of another kind and new questions are continually coming forward to be solved. The possibility of developing profitable mining properties, the value of clay deposits for the manufacture of brick and other wares, the suitability of marls and clay for the manufacture of Portland cement, the depth to which it will be necessary to bore in order to obtain water in different localities, the possibility of developing quarries of building and other stone, the utilization of quartz and other minerals which occur

in varied abundance, the determination of minerals for the satisfaction of the people, are questions which are constantly recurring year after year, which can only be answered by a department which is prepared to render professional advice. If an appropriation should be made for two years, it simply means that the state is providing for a limited time professional services which must be withheld during the subsequent years unless the appropriation is renewed. The experience of the past three and a half years has shown that there are also numerous scientific questions which the state ought to investigate but which will be more profitably studied by an investigation extending over several years than by the expenditure of a larger sum for a shorter time. Such are, for instance, the problems relating to water supply and the study of our lakes, both from the economic and scientific point of view. Numerous new questions are to be settled, whose solution will involve time, and whose study ought to extend over a term of years. The same may be said of the duty of preparing educational bulletins, with which the statute of 1897 charged the Survey. These can best be prepared in the manner which the Survey has been following in the past, taking up one topic after another and thus extending the completion of this series of bulletins over a considerable number of years. In planning for the future, therefore, I would strongly recommend that the Commissioners request of the Legislature such an appropriation as will enable the Survey to carry on its present departments strongly and efficiently and to provide for a moderate extension of its work to those parts of the state and to some of those subjects which it has hitherto been unable to reach. I should also urgently recommend that they request the Legislature to make the appropriation a permanent one, so that the work of the Survey may be planned, not with reference to the two-year period, as has been necessary in the past, but with a view of distributing its investigations over a longer time and thus accomplishing its duties more effectually and more economically.

Respectfully submitted,

E. A. BIRGE,

October 1, 1900.

Director and Superintendent.

FINANCIAL REPORT, FROM SECRETARY OF STATE.

GEOLOGICAL SURVEY.

Oct. 1, 1898—Sept. 30, 1899.

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|--------------------------------------|----------|
| Alexander, A. A. | \$12 50 |
| Anthony, G. | 51 05 |
| American and U. S. Express Cos. | 50 33 |
| Anson, C. H. St. J. | 43 50 |
| Birge, E. A. | 640 04 |
| Buckley, E. R. | 1,493 03 |
| Berkey, Chas. P. | 150 00 |
| Bausch & Lomb Optical Co. | 9 22 |
| Chandler, E. F. | 4 90 |
| Clements, J. M. | 5 20 |
| Chamberlain, P. | 18 80 |
| Coen, B. F. | 18 45 |
| Cole, Chas. | 185 25 |
| Denniston, F. K. | 114 12 |
| Eimon Mercantile Co. | 19 31 |
| Frost, G. W. | 22 31 |
| Grant, U. S. | 820 71 |
| Hedke, Chas. R. | 24 20 |
| Harper, Blanche | 36 33 |
| Hegg, J. R. | 4 30 |
| Hollister's Pharmacy | 8 77 |
| Hobbs, Wm. H. | 21 81 |
| Holden, R. J. | 13 50 |
| Heine, R. E. | 4 00 |
| Hinman, A. S. | 109 00 |
| Hemingway, E. E. | 93 30 |
| Johnson, Harry | 18 00 |
| Knowles, J. H. | 14 30 |
| Leith, C. K. | 98 92 |
| Lottes, W. G. | 4 80 |
| Kny-Scheerer Co. | 53 75 |
| Lord Bros. Jewelry Co. | 4 25 |
| Martindale, J. W. | 91 00 |
| Marsh, C. D. | 251 78 |
| Montello Granite Co. | 16 00 |
| McLaggan, K. W. | 58 60 |
| Nommensen, R. A. | 17 70 |
| Nicholson, J. F. | 18 00 |
| Nicholson, D. P. | 238 00 |
| Ohm's, Fred C., Son | 59 40 |
| Pickarts & Nicodemus | 3 00 |
| Pease-Humphrey Hardware Co. | 12 85 |
| Philbrook & Tubbs | 47 69 |
| Rathbun, R. | 86 30 |
| Stone, M. B. | 61 10 |
| Sumner, L. D. | 5 25 |
| Smith, W. N. | 119 62 |
| Smith, L. S. | 395 68 |

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| Smith, A. F. | 43 10 |
| Sanford, Fannie G. | 15 85 |
| Salisbury, R. D. | 400 00 |
| Silbernagel, J. J. | 78 00 |
| Van Hise, C. R. | 66 58 |
| Weidman, S. | 1,312 60 |
| Winslow, H. G. | 7 00 |
| Wilson, J. | 11 55 |

\$7,584 60

Oct. 1, 1899—Sept. 30, 1900.

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| American Express Co. | \$304 45 |
| Atwood, W. A. | 5 00 |
| Allis Co., Edw. P. | 13 40 |
| Allyn, Abbie | 161 11 |
| Buckley, E. R. | 2,161 61 |
| Buckley, F. M. | 15 40 |
| Birge, E. A. | 1,114 27 |
| Becker, Christian | 134 00 |
| Bausch & Lomb Optical Co. | 32 15 |
| Buehler, H. A. | 48 20 |
| Conlin, D. F. | 7 25 |
| Cassels, Geo. H. | 12 12 |
| C., M. & St. P. R. R. | 18 50 |
| Comstock, E. H. | 7 50 |
| Clark & Mills | 400 00 |
| Capital City Paper Co. | 9 55 |
| Denniston, F. K. | 50 00 |
| Daniells, W. W. | 206 75 |
| Democrat Printing Co. | 24 75 |
| Eimer & Amend | 169 93 |
| Ferris, W. S. | 78 00 |
| Frost, G. W. | 4 80 |
| Fenneman, N. M. | 131 75 |
| Gurley, W. & L. E. | 56 05 |
| Gould, Wells & Blackburn | 22 67 |
| Greig, J. | 12 50 |
| Grant, U. S. | 1,407 68 |
| Holden, R. J. | 3 05 |
| Harper, B. | 26 67 |
| Hoyt, W. A. | 7 75 |
| Hargrove, R. W. | 6 50 |
| Hedke, Chas. R. | 8 20 |
| Icke, John | 12 70 |
| Illinois Supply & Construction Co. | 25 50 |
| Juday, C. | 119 20 |
| Kraatsche, H. | 11 37 |
| Marsh, C. D. | 145 77 |
| Minneapolis Office & School Furniture | 21 54 |
| Nicholson, D. P. | 148 50 |
| Nelson J. Lloyd | 238 17 |
| Ohm's, Fred C., Son | 33 85 |
| Peppel, S. V. | 745 80 |
| Pickarts & Nicodemus | 5 00 |
| Peterson, C. N. | 3 00 |
| Rust, Owen, Lumber Co. | 57 52 |
| Richards & Co. | 11 50 |

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| Springer Torsion Balance Co. | 17 00 | |
| Stone, M. B. | 2 75 | |
| Stephenson & Studeman | 12 85 | |
| Smithsonian Institute | 55 70 | |
| Smith, L. S. | 339 20 | |
| Shane, N. A. | 57 73 | |
| Snyder, T. L. | 10 59 | |
| Standard Telephone & Electric Co. | 14 35 | |
| Sanford, F. G. | 110 00 | |
| Shepard, H. L. | 18 00 | |
| Silbernagel, J. J. | 38 00 | |
| Smith, A. F. | 41 30 | |
| Tyrrell, James | 246 61 | |
| Van Hise, C. R. | 8 63 | |
| U. S. Express Co. | 123 35 | |
| University Co-Operative Co. | 14 68 | |
| Weidman, S. | 1,535 12 | |
| Wykoff, Seamans & Benedict | 87 75 | \$11,109 27 |
| Total, two years | | \$18,693 87 |

STATUTES OF WISCONSIN RELATING TO THE GEOLOGICAL AND NATURAL HISTORY SURVEY.

CHAPTER 297, LAWS OF 1897.

An Act to provide for the investigation of the natural resources of the state of Wisconsin, and providing an appropriation therefor.

The people of the state of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. There is hereby constituted a geological and natural history survey of the state of Wisconsin.

SECTION 2. This survey shall have for its object:

(1) The completion of the geological survey of the state, and especially the examination of the rocks, with reference to the occurrence of iron ores, building stones, and other valuable mineral products, and in reference to their value as material for road construction.

(2) A study of the soils of the state.

(3) A study of the plants of the state, and especially of the forests, with reference to their cultivation and preservation.

(4) A study of the animal life of the state, and especially the occurrence, distribution, and production of fish in the lakes and streams of the state, and a study of foods and enemies of fish.

(5) The preparation of an account of the physical geography and natural history of the state, in such form as to serve as manuals for the public schools, and of special reports on subjects of economic importance, in such form as to be of direct service to the people.

(6) The completion of the topographic map of the state begun by the United States Geological Survey; but no money shall be expended for topography unless an equivalent amount be expended for this purpose in the state by the United States government.

SECTION 3. This survey shall be governed by a board of commissioners, consisting of the governor of the state, the state superintendent of public instruction, the president of the state university, the president of the commissioners of fisheries, and the president of the Wisconsin Academy of Sciences, Arts and Letters. The commissioners shall meet within thirty days after the passage of this act, and organize as a commission and adopt by-laws for their government, not inconsistent with law, and shall meet at such time and places as they may prescribe. A majority shall be a quorum. They shall receive no compensation, but each shall be reimbursed his expenses actually and necessarily incurred in the performance of his official duties, out of such appropriation as may be made by the legislature. They shall choose from their number a president, secretary, and such other officers as their by-laws may prescribe; but no officer shall receive any compensation, except such as is herein provided for. The commissioners shall have general charge of the survey, and shall appoint a superintendent of the survey, and, on his nomination, such assistants and employees as they may deem necessary. They shall fix the compensation of all persons employed in the survey, and may remove them at pleasure.

SECTION 4. It shall be the duty of the commissioners to prepare a report before the meeting of each legislature, showing the progress and condition of the survey, giving an account of money spent, together with such other information as may be deemed necessary and useful. The superintendent shall transmit to the commissioners, from time to time, special reports, with necessary illustrations and maps, as these are completed. If approved by the commissioners, they shall be transmitted to the commissioners of public printing, who are authorized to have the reports published in a suitable manner, as independent reports, as bulletins of the state university, or in the transactions of the Wisconsin academy of sciences, arts, and letters, as the commissioners of the survey deem best. If published as independent reports, it shall be the duty of the commissioners of public printing to decide as to the number of copies in the edition of each particular report. Five copies of each report shall be delivered to each of the state officers, and to each member of the legislature. The number of copies provided by law for other public documents shall be furnished to the state historical society, the library of the state university, and other state institutions. The remainder of the independent reports shall be distributed, used in exchange, or sold by the commissioners of the survey, as the interest of the state and of science demands. All moneys obtained by the sale of the report shall revert to the state treasury, as a part of the general fund. Volumes obtained in exchange for the reports shall be added to the library of the Wisconsin academy of sciences, arts, and letters. The superintendent of public property shall furnish, upon the requisition of the president of the commissioners of the survey, such stationery and postage stamps as may be necessary for the use of the commissioners and the superintendent of the survey in official business.

SECTION 5. After material collected shall have served for the purposes of the survey, it shall be distributed to the state university, the colleges of the state, the state normal schools, and the free high schools of the state, under the approval of the commissioners of the survey, in such a manner as to be of the greatest advantage to education in the state.

SECTION 6. There is hereby annually appropriated for two years to the commissioners of the geological and natural history survey, out of any money in the treasury not otherwise appropriated, the sum of \$5,000, the first appropriation to be paid in the current fiscal year.

SECTION 7. This act shall take effect and be in force from and after its passage and publication.

Approved April 22, 1897.

CHAPTER 163, LAWS OF 1899.

An Act to appropriate a sum of money for the further prosecution of the geological and natural history survey of the state.

The people of the state of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. There is hereby appropriated for the further prosecution of the geological and natural history survey, out of any money in the treasury not otherwise appropriated, the sum of ten thousand dollars annually for the term of two years. This money shall be expended by the commissioners of said survey for the purpose of executing the duties assigned to them by chapter 297 of the laws of 1897.

SECTION 2. This act shall take effect and be in force, from and after its passage and publication.

Approved April 12, 1899.

PUBLICATIONS OF THE SURVEY.

1. BULLETINS.

The publications of the Survey are issued as bulletins, which are numbered consecutively, and each bulletin is independently paged and indexed, no attempt being made to group them in volumes. The bulletins are issued in three series:

A. *Scientific Series*.—The bulletins so designated consist of original contributions to the geology and natural history of the state, which are of scientific interest rather than of economic importance.

B. *Economic Series*.—This series includes those bulletins whose interest is chiefly practical and economic.

C. *Educational Series*.—The bulletins of this series are primarily designed for use in the schools.

The following bulletins have been issued:

BULLETIN No. I. ECONOMIC SERIES No. 1.

On the Forestry Conditions of Northern Wisconsin. Filibert Roth, Special Agent, United States Department of Agriculture. 1898. Pp. VI., 78; 1 map. Sent on receipt of 10c.

BULLETIN No. II. SCIENTIFIC SERIES No. 1.

On the Instincts and Habits of the Solitary Wasps. George W. Peckham and Elizabeth G. Peckham. 1898. Pp. IV., 241; 14 plates, of which 2 are colored; 2 figures in the text. Sold at the price of \$1.50 in paper and \$2.00 bound.

BULLETIN No. III. SCIENTIFIC SERIES No. 2.

A Contribution to the Geology of the Pre-Cambrian Igneous Rocks of the Fox River Valley, Wisconsin. Samuel Weidman, Ph. D., Assistant Geologist Wisconsin Geological and Natural History Survey. Pp. 63; 10 plates; 13 figures in the text. Sent on receipt of 10c.

BULLETIN No. IV. ECONOMIC SERIES No. 2.

On the Building and Ornamental Stones of Wisconsin. Ernest Robertson Buckley, Ph. D., Assistant Geologist Wisconsin Geological and Natural History Survey. 1898 (issued in 1899). Pp. XXVI., 544; 69 plates, of which 7 are colored, and 1 map. Sent to citizens of Wisconsin on receipt of 30c; to others for \$1.25.

BULLETIN No. V. EDUCATIONAL SERIES No. 1.

The Geography of the Region About Devil's Lake and the Dalles of the Wisconsin, with some notes on its surface geology. By Rollin D. Salisbury, A. M., Professor of Geographic Geology, University of Chi-

cago, and Wallace W. Atwood, B. S., Assistant in Geology, University of Chicago. 1900. Pp. X, 151; 38 plates; 47 figures in the text. Sent on receipt of 30c.

BULLETIN No. VI. ECONOMIC SERIES No. 3.

Preliminary Report on the Copper-Bearing Rocks of Douglas County, Wisconsin. By Ulysses Sherman Grant, Ph. D., Professor in Northwestern University. 1900. Pp., 55; 11 plates. Sent on receipt of 5c.

2. BIENNIAL REPORTS.

Besides these bulletins the Survey has published two biennial reports, which relate to administrative affairs only and contain no scientific matter:

First Biennial Report of the Commissioners of the Geological and Natural History Survey. 1899. Pp. 31.

Second Biennial Report of the Commissioners of the Geological and Natural History Survey. 1901. Pp. 44.

3. FORTHCOMING BULLETINS.

The following bulletins will be issued early in the year 1901:

BULLETIN No. VI. ECONOMIC SERIES No. 3. (Second Edition.)

Preliminary Report on the Copper-Bearing Rocks of Douglas County, and Parts of Washburn and Bayfield Counties. Ulysses Sherman Grant, Professor of Geology, Northwestern University.

BULLETIN No. VII. ECONOMIC SERIES No. 4.

The Clays and Clay Industries of Wisconsin. Part I. E. R. Buckley, Assistant Superintendent, Wisconsin Geological and Natural History Survey. In charge of Economic Geology.

BULLETIN No. VIII. SCIENTIFIC SERIES No. 3.

The Pre-Cambrian Igneous Rocks of the Lower Fox River Valley. W. H. Hobbs, Professor of Mineralogy, University of Wisconsin, and C. K. Leith, Geologist, United States Geological Survey.

The following bulletins are in an advanced state of preparation, the first two on the list being nearly ready for the printer:

The Temperature of Lakes in Southern Wisconsin. E. A. Birge, Director, Wisconsin Geological and Natural History Survey.

The Lake Region of Northern Wisconsin. D. P. Nicholson, Professor of Geology, Lawrence University.

The Forest Trees of Wisconsin. L. S. Cheney, Assistant Professor of Pharmaceutical Botany, University of Wisconsin.

The Physical Geography of the Lakes of Southern and Eastern Wisconsin. N. M. Fenneman, Assistant, Wisconsin Geological and Natural History Survey.

4. HYDROGRAPHIC MAPS.

There have been prepared hydrographic maps of the principal lakes of southern and eastern Wisconsin. This work is in charge of L. S. Smith, Assistant Professor of Topographical Engineering, University of Wisconsin.

The following maps are now printed:

- No. 1. Lake Geneva.
- No. 2. The Oconomowoc-Waukesha Lake District.
- No. 3. Lake Beulah.
- No. 4. Elkhart Lake.
- No. 5. The Chain of Lakes, Waupaca.
- No. 6. Delavan and Lauderdale Lakes.
- No. 7. Green Lake.
- No. 8. Lake Mendota.

| | Size of Plate, Inches. | Scale, Inches Per Mile. | Contour Inter- val, Feet. |
|-------------|---------------------------|----------------------------|------------------------------|
| No. 1 | 17.5x10.8 | 2 | 10 |
| No. 2 | 29.8x19.1 | 2 | 10 |
| No. 3 | 22.5x20.0 | 6 | 10 |
| No. 4 | 15.5x13.1 | 5 | 10 |
| No. 5 | 21.7x20.6 | 6 | 10 |
| No. 6 | 22.5x16.8 | 4 | 10 |
| No. 7 | 26.0x17.8 | 3.2 | 20 |
| No. 8 | 23.7x19.5 | 6 | 5 |

In all of these maps the depth of the lakes is indicated by contour lines, and by tints in all except No. 1. They are sent on receipt of 15 cents each, except Nos. 2 and 8, for which 20 cents are required. They may be had either mounted in a manilla cover, or unmounted.

The following maps are now being printed:

- No. 9. Big Cedar Lake.
- No. 10. Lake Monona.

Map No. 11, Lakes Waubesa and Kegonsa, is in the hands of the draughtsman.

All correspondence relating to the Survey should be addressed to

E. A. BIRGE, *Director*,
Madison, Wis.



